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Supplimental
report to
phase 1 of
project

A PRELIMINARY WATER QUALITY STUDY OF
THE ROCK CREEK WATERSHED
CHICKASAW NATIONAL RECREATION AREA

Submitted to

United States Department of the Interior
National Park Service
Southwest Region
P.O. Box 728
Santa Fe, New Mexico 87501

Prepared by

Dr. Leale E. Streebin
and
Margaret Johanning
School of Civil Engineering and Environmental Science
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Norman, Oklahoma 73069

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INTRODUCTION

The University of Oklahoma, School of Civil Engineering and Environmental Science, completed phase I of the water quality study on the Rock Creek Watershed. The study provided additional information to earlier studies and data on point and dispersed sources of pollution in an effort to isolate problem areas in the Chickasaw National Recreational Area.

The objectives of the study were to : 1) collect data that might disclose a change in the water quality of Rock Creek, the Lake of the Arbuckles, and their tributaries resulting from adjacent land use; 2) isolate waste sources, both dispersed and point; 3) compare the water quality with the beneficial uses for Rock Creek, the Lake of the Arbuckles, and their main tributaries and ; 4) determine the effects of swimming on water quality.

DESCRIPTION OF THE WATERSHED

The Rock Creek Watershed covers an area of 170.4 sq mi in the central part of Murray County, the southeastern part of Garvin County, and the Southwestern part of Pontotoc County. The main tributaries sampled were Guy Sandy and Buckhorn Creeks. The topography of the watershed ranges from gently rolling hills in the north to rough and broken terrain in the south.

The major soils in the basin are Chigley-Windthorst-Roff, and Durant-Heiden-Steedman. The Chigley-Windthorst-Roff association is

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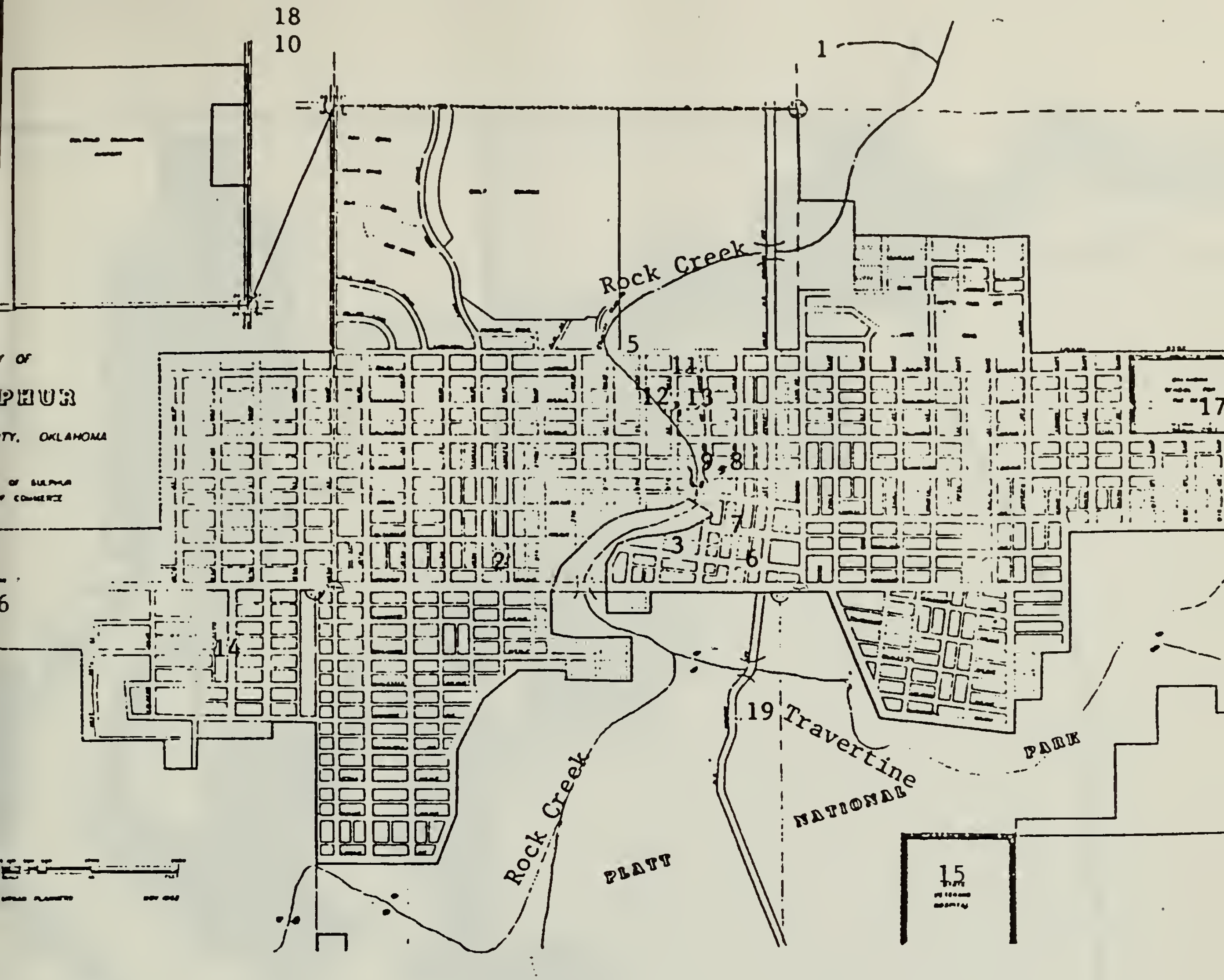
deep, gently sloping to strongly sloping, upland soils with gravelly to clayey subsoils. The Durant-Heiden-Steedman association is deep to moderately deep, nearly level to gently sloping, prairie soils with clayey subsoils.

Sulfur, the Murray County seat, had an estimated population of 5,600 for 1975. The present source of the city's drinking water is seven untreated water wells; future needs will be met by using the Lake of the Arbuckles. The city has an extended aeration treatment plant that discharges into the Washita River. The industries in the city of Sulphur are listed in Figure 1.

Also contained within the Rock Creek Watershed is the Chickasaw National Recreation Area. It is composed of the Platt Section Adjacent to the city of Sulphur, the Lake of the Arbuckles (approximately 8 miles southwest of the Platt Section in the Arbuckle Mountains), and the land around these areas (Figure 2).

The Chickasaw National Recreation Area was designated in March 1976 by Congress to honor the Chickasaw Indian Nation. Prior to the renaming, the Platt Section was Platt National Park, a recreation area located in the foothills of the Arbuckle Mountains. It covered approximately 910 acres of woodlands and gently rolling grass covered hills. In addition to containing a wide range of native vegetation, birds and animals (the western part is a bison range) the park provides opportunities for picnicking, camping, hiking and swimming or wading.

The Platt Section contains two major waterways, Rock Creek (a tributary of the Washita River) and Travertine Creek (which is fed by two large freshwater springs, Buffalo and Antelope Springs). This section's unique attraction is the cold-water mineral springs. Most



Map No.	Company Name
1.	O.G. & E. GENERATING PLANT
2.	KRAFT FOODS CO.
3.	SHI-MAID METAL MFG. CO.
4.	PENNSYLVANIA GLASS & SAND CO.
5.	DOLESE CO.
6.	TIMES DEMOCRAT
7.	LAYCO, INC.
8.	CARPENTER EGG CO.
9.	HAINES, INC.
10.	SCHWANS FROZEN FOODS
11.	ASSOCIATED MILK PRODUCERS, INC.
12.	DODSON CONSTRUCTION CO.
13.	L. & R. CONSTRUCTION CO.
14.	NELSON CONSTRUCTION CO.
15.	OKLAHOMA VETERANS CENTER
16.	ARBUCKLE MEMORIAL HOSPITAL
17.	OKLAHOMA SCHOOL FOR THE DEAF
18.	SOUTHERN OKLAHOMA RURAL SKILL CENTER
19.	NATIONAL PARK SERVICE

Figure 1. INDUSTRIES OF SULPHUR, OKLAHOMA

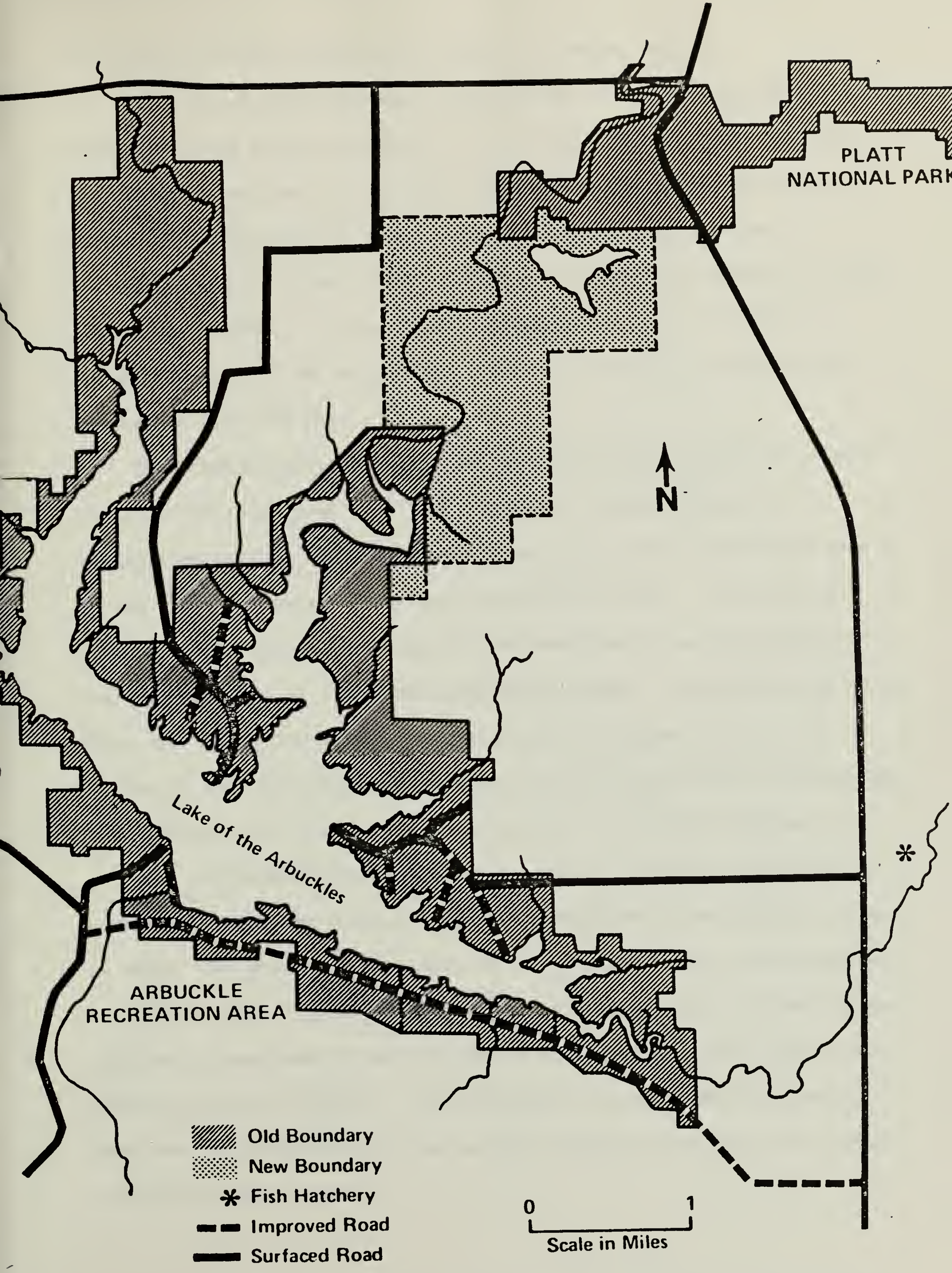


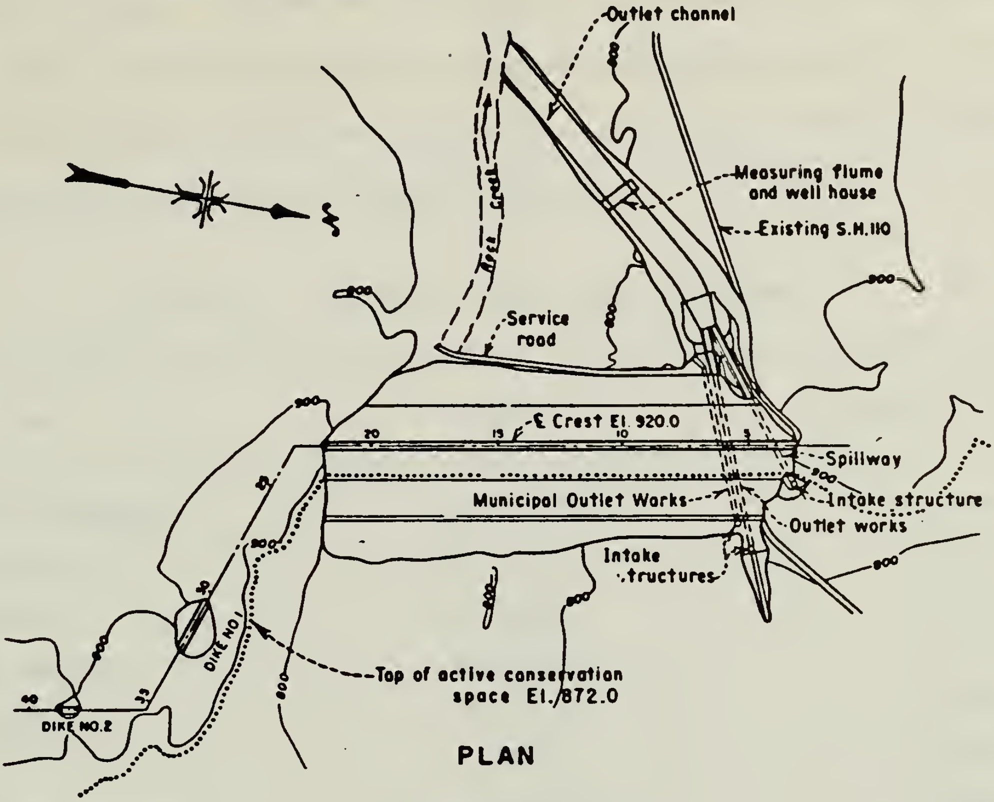
FIGURE 2 PLATT SECTION AND LAKE OF THE ARBUCKLES IN CHICKASAW NATIONAL RECREATION AREA

of these are sulfur springs but three are bromide springs.

The Lake of the Arbuckles on Rock Creek is in the Arbuckle Mountains about 8 miles southwest of the Platt Section. The Arbuckle Mountains in southcentral Oklahoma are low, rugged limestome mountains rising to an elevation of about 1,450 feet above mean sea level. The prairie lands to the north and east of the mountain range are called the Sandstone Hills. On the north and west, the prairie lands are referred to as the Red Bed Plains. South and east of the reservoir is the Red River Valley.

The arbuckle project consisting of the dam, reservoir and related pipelines was completed in 1966. Intially, it was a Bureau of Reclamation project but its operation and maintenance was transferred to the Arbuckle Master Conservancy District in 1968. The National Park Service, however, is primarily responsible for administering the recreational uses of the 5,600 acre project area. The project provides flood control, water supply for the cities of Sulphur, Davis, and Wynnewood, recreational opportunities and fish and wildlife propagation. Some physical data on the dam and reservoir is listed in Figure 3.

The Chickasaw National Recreation Area is a unique recreational facility within easy acess to many Oklahomans and out-of-state visitors as well. The annual visitor days of use for the Lake of the Arbuckles is 358,000 (1975 figure by USDI). The beneficial uses provided by the lake and streams make it an attractive recreational area as well as a valuable natural resource. The condition of Rock Creek is especially important in maintaining a high quality reservoir that can also remain a municipal water supply.



PHYSICAL DATA

DAM

Type		Zoned earthfill
Hydraulic height . . . (above streambed)	(feet)	140
Crest length . . . (exclusive of dikes)	(feet)	1,890
Crest width	(feet)	30
Base width	(feet)	770
Crest length of dikes	(feet)	320
Volume	(cu. yds.)	2,850,000
Spillway capacity	(c.f.s.)	3,410
Outlet capacity (river)	(c.f.s.)	2,340

RESERVOIR

Capacity at spillway crest, elevation 885.3 . . . (Acre-feet)	108,800
Area at spillway crest, elevation 885.3 . . . (Acres)	3,127
Area at top of active conservation surface, elevation 872.0	2,349
Municipal and industrial water yield	
Acre-feet annually	24,000
Million gallons daily	21.42
Wynnewood pumping plant capacity . . . (c.f.s.)	9.6
Wynnewood pipeline (includes Davis Branch)	
Length . . . (miles)	19.8
Diameter	24 inches to 12 inches

Municipal & industrial water allotment:-

Water User	Million Gallons Daily	Acre-feet Annually
Sulphur	1.21	1,359
Wynnewood	0.70	780
Davis	1.32	1,485
State of Oklahoma	18.19	20,376
Total	21.42	24,000

(USDI pamphlet)

Figure 3. PHYSICAL DATA FOR LAKE OF THE ARBUCKLES

LAND USE ACTIVITIES

The water quality of the Rock Creek Watershed is a function of the adjacent land use. Dispersed pollution from agricultural and forest lands, urban runoff and the point sources discharging into the creek affect its quality. Land use in the 124 sq mi area of the Rock Creek watershed above the dam is listed in Table 1.

Table 1. LAND USE, ROCK CREEK WATERSHED

Use	Acres	Percent of Total
Natural grassland	39,587.20	49.803
Pastureland	16,120.00	20.280
Rangeland	9,220.80	11.600
Forest upland	8,880.00	11.171
Cultivated	3,240.00	4.076
Lakes	2,360.00	2.969
Forest bottomland	80.00	0.101
TOTAL	79,488.00	100.000

Note: Information from the United States Soil Conservation Service Miads

More and more of the agricultural activity in Murray County is turning to beef and dairy production. The land is being restored to pastureland. The principal crops are oats, alfalfa and wheat and most are grown in the bottomland along the Washita River. A major reason for the reduction in crop production is due to poor soil sturctures and soil fertility and also due to the poor drainage of the soils. Some of the wooded areas along the Washita River are being eradicated for use as rangeland.

Summmer home development on the west side of the Lake of The Arbuckles may affect the water quality if the sub-surface sewerage systems are not properly installed. The natural drainage in the area is toward the Arbuckle Lake. It can be expected that improperly treated sewage will find its way to the lake. The immediate environmental impact of the housing development is the sedimentation resulting from the highly erodible soil.

BENEFICIAL USES AND WATER QUALITY OF ROCK CREEK AND LAKE OF THE ARBUCKLES

Water quality of a stream is determined by the stream's beneficial uses. The Oklahoma Water Quality Standards (1973) set forth the beneficial uses of the waters of the state as listed below:

CODE	BENEFICIAL USE
A	Public and private water supplies
B	Emergency public and private water supplies
C_1	Fish and wildlife propagation
C_2	Fish and wildlife propagation to the extent allowed by specifically stated water quality parameters
D	Agriculture (includes livestock watering and irrigation)
E	Hydroelectric power
F_1	Industrial and municipal cooling water
F_2	Receiving, transporting and/or assimilation of adequately treated waste
G_1	Recreation, primary body contact (includes recreational uses where the human body may come in direct contact with the water to the point of complete body submergence)
G_2	Recreation, secondary body contact (includes recreational uses, such as fishing, wading, and boating, where ingestion of water is not probable)
H	Navigation
I	Aesthetics
J	Small-mouth bass fishery excluding lake waters
K	Trout fishery (put-and-take)

Rock Creek and the Lake of the Arbuckles have been designated as A, C_1, D, F_1, F_2, G_1 and I. These designations characterize the various uses of the water in Rock Creek and the Lake of the Arbuckles.

A major use of the water in the Platt Section of the recreation area is devoted to recreational activities. There are many public swimming areas and during the summer, thousands of people camp, swim, and picnic along the streams.

The Lake of the Arbuckles, approximately 8 miles southwest of the Platt Section, was built by the Bureau of Reclamation and completed in 1966. The primary purpose of the lake was for flood control and water

supply. The Lake of the Arbuckles and its main tributary, Rock Creek, are water supplies of the town of Sulphur, Davis, and Wynnewood. Recreational uses of the reservoir include boating, fishing, water skiing, swimming, scuba diving, camping and picnicking.

The Chickasaw National Recreation Area also serves as a sanctuary for a variety of birds, animals, and aquatic life. Thus, the waters serve another important use for fish and wildlife propagation.

Water quality is used to describe the nature of water in terms of its components. The quality of water in a stream or reservoir determines its uses and effects on the environment.

According to the beneficial use categories for Rock Creek and the Lake of the Arbuckles as listed in the *Oklahoma Water Quality Standards*, the following water quality criteria are established:

Bacteria. Bacteria of the fecal coliform group shall not exceed a a monthly geometric mean of 200/100 ml, as determined by the membrane filter procedure and based on a minimum of not less than five samples for any 30-day period, nor shall more than 10% of the total samples during any 30-day period exceed 400/100 ml.

Dissolved oxygen (DO). The dissolved oxygen concentration shall not be less than 5 mg/l for all warm waters.

pH. The pH shall be between 6.5 and 8.5. pH values below 6.5 and above 8.5 must not be due to waste discharge.

Turbidity. Turbidity of other than natural origin shall be restricted to the following in-stream numerical values:

warm water streams	50 Jackson units
warm water lakes	25 Jackson units

Temperature. During any month of the year, heat shall not be added to any stream in excess of the amount that will raise the temperature of the water more than 5°F. In lakes, the temperature of the epilimnion shall not be raised more than 3°F above which existed before the addition of heat of artificial origin.

Nutrients. The total phosphorus concentration and nitrogen/phosphorus ratio shall be limited to prevent eutrophication problems.

Toxic substances. Toxic substances shall not be present in such quantities as to cause the waters to be toxic to human, animal, plant, and aquatic life, not detrimental to any beneficial use including continued ingestion by livestock or continued use for irrigation. For aquatic life, using bioassay techniques, the toxic limit shall not exceed one-tenth of the 96-hour median tolerance limit for the most sensitive species common to the stream.

The waters of the Chickasaw National Recreation Area provide a wide variety of beneficial uses for man as well as providing food and shelter for the wildlife in the area. The significance of these uses to the welfare of man and his ecological community cannot be denied. Preserving and maintaining high quality waters as nearly pollution free as possible is both a necessary and responsible activity.

PRESENTATION OF DATA

The establishment of baseline data to determine the trends in water quality as related to dispersed and point sources of pollution was a prime objective in the selection of the sampling stations on Rock Creek, the Lake of the Arbuckles, and their tributaries. Another objective was to compare the present water quality of Rock Creek to the state's standards.

The location of the sampling stations (Figures 4a., b.) were selected to identify any conditions which might be detrimental to the intended uses of Rock Creek and the Lake of the Arbuckles.

Sampling stations 1-4, 9-11, and 13-15 are all located in the Platt Section where the principle activity is recreation, including primary body contact water sports. Any change in water quality resulting from these activities would be reflected between these stations. Stations 5-8 are located on Rock Creek north of the Platt Section. Above these sampling sites, the adjacent land uses include some ranching and farming. Between stations 5 and 8 on Rock Creek, the adjacent land uses are for urban and industrial activities. Sulphur Municipal Treatment Facility is located at sampling point 12. Although the waste is pumped form the Rock Creek Basin to the Washita a sampling site was selected in that area to monitor the stream for any possible overflow from the waste retention lagoon. Sampling sites 16-20 are located on the Lake of the Arbuckles. Sampling sites 16-18 were selected to determine the water quality entering Arbuckle Lake while stations 19 and 20 were selected to determine the water quality leaving the lake through the spillway.

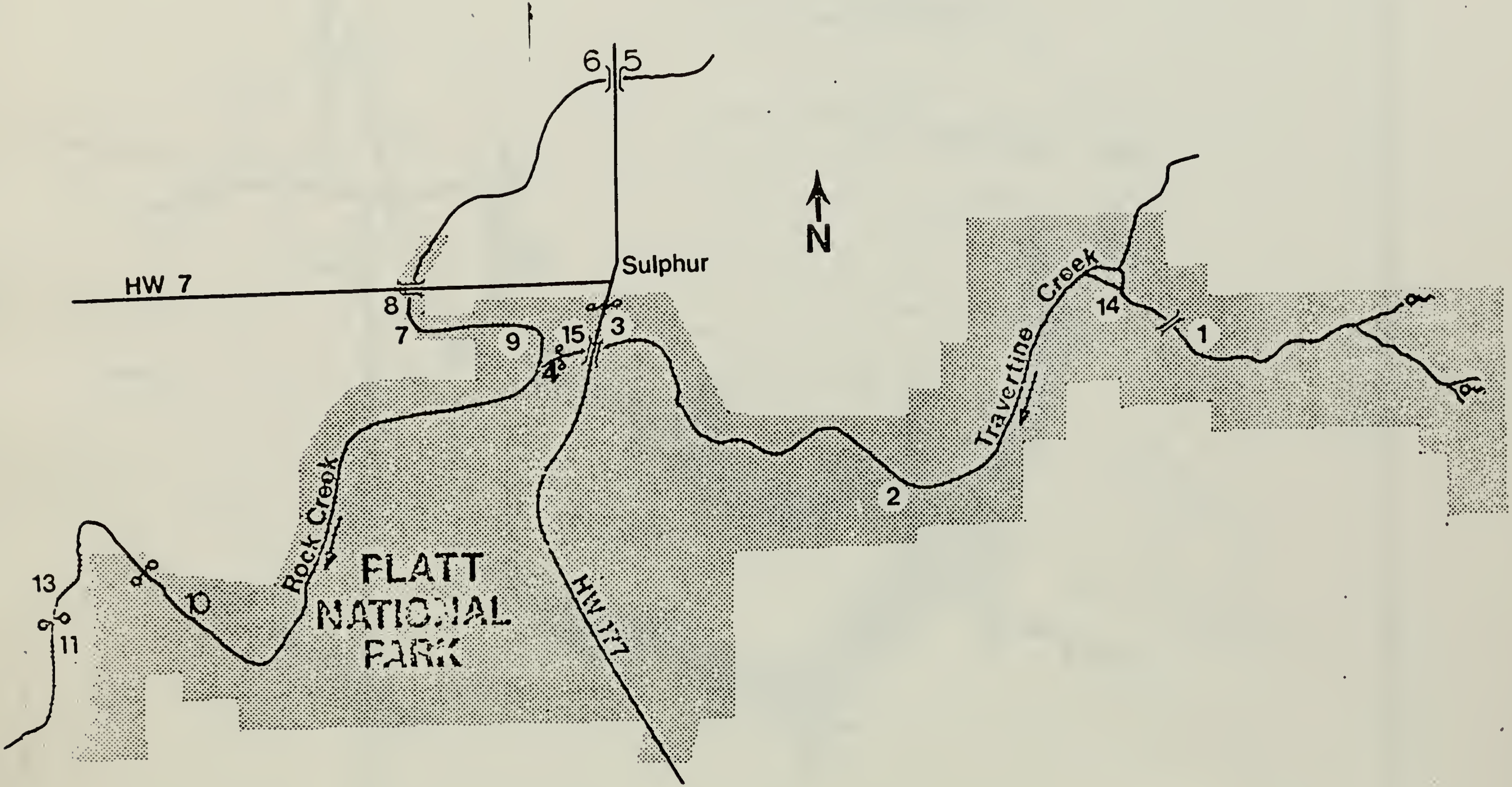


Figure 4a SAMPLING SITES—ROCK CREEK—CHICKASAW NATIONAL RECREATION AREA

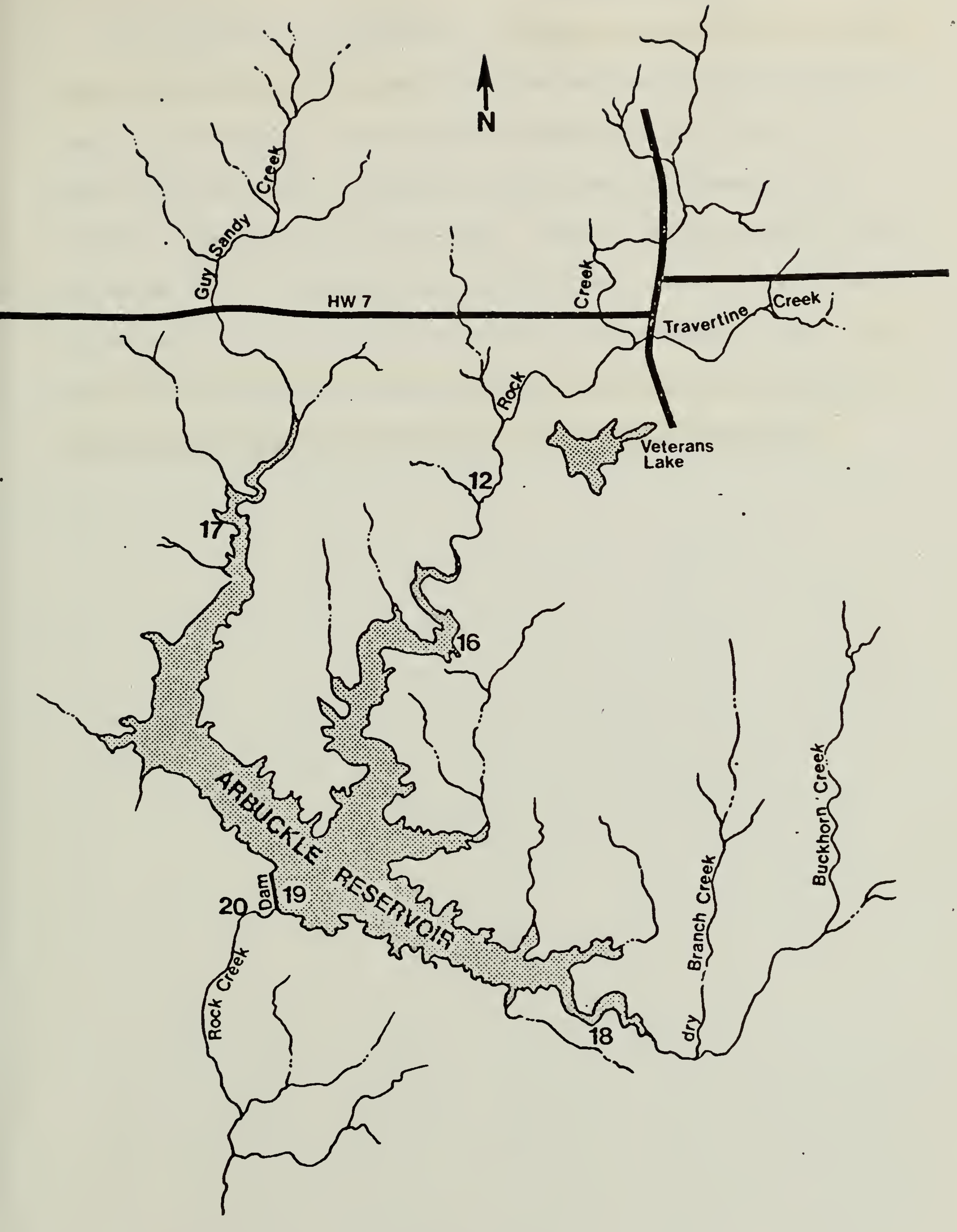


Figure 4b

SAMPLING SITES–ARBUCKLE RESERVOIR–CHICKASAW NATIONAL RECREATION AREA

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Summer high for park visitation

The results of the analyses of samples collected from June 1976 through September 1976 in the Chickasaw National Recreation area and Lake of the Arbuckles can be seen in tables 2-4 and figures 5-9. Table 2 and 2a lists the quality criteria data for sample sites 1-15 on Travertine and Rock Creeks. Table 3 lists the quality data for sites 16-20 on the Lake of the Arbuckles. Table 4 lists the biological data associated with swimmers in Travertine Creek. The laboratory analyses were performed according to the 13th edition of *Standard Methods for the Examination of Water and Wastewater*.

total dissolved solids

Choride

chemical oxygen demand

Dissolved oxygen

Site	Date	DO	COD	Cl	TDS	pH	TSS	Temp.	Alkalinity
TRAVERTINE CREEK									
1. Below Nature Center	6/14	9.1	13.3	2.0	550	9.0	1.2	22	---
2. Below swimming area		---	---	---	---	---	---	---	---
3. Culvert E. of HY 177		10.4	---	58.0	500	9.0	47.1	24	---
4. Inverted siphon below Lincoln bridge		---	---	---	---	---	---	---	---
1. Below Nature Center	6/16	9.6	12.7	2.0	550	8.8	4.4	21	270.9
2. Below swimming area		---	---	---	---	---	---	---	---
3. Culvert E. of HY 177		---	---	---	---	---	---	---	---
4. Inverted siphon below Linclon bridge		9.3	8.5	70.0	690	9.0	6.4	22	212.5
1. Below Nature Center	6/18	---	---	---	---	---	---	---	---
2. Below swimming area	raining	---	---	---	---	---	---	---	---
3. Culvert E. of HY 177		6.8	87.0	15.0	---	7.4	173.0	24.5	137.5
4. Inverted siphon below Lincoln bridge		---	---	---	---	---	---	---	---
1. Below Nature Center	6/23	7.3	27.4	4.0	550	8.0	---	21.5	391.7
2. Below swimming area		---	---	---	---	---	---	---	---
3. Culvert E. of HY 177		---	---	---	---	---	---	---	---
4. Inverted siphon below Lincoln bridge		9.6	21.6	61.0	700	8.0	---	26.0	341.7
1. Below Nature Center	6/29	---	---	---	---	---	---	---	---
2. Below swimming area		---	---	---	---	---	---	---	---
3. Culvert E. of HY 177		8.9	9.7	4.0	500	8.3	8.0	23.5	343.7
4. Inverted siphon below Lincoln bridge		---	---	---	---	---	---	---	---

	Site	Date	DO	COD	Cl	TDS	pH	TSS	Temp.	Alkalinity
ROCK CREEK										
5.	HY 177 above bridge	6/14	---	---	---	---	---	---	---	---
6.	HY 177 below bridge		---	---	---	---	---	---	---	---
7.	HY 7 below bridge		9.5	13.3	177.9	680	8.9	1.4	25	---
	Under HY 7 bridge		---	---	---	---	---	---	---	---
8.	Culvert below HY 7		---	---	---	---	---	---	---	---
9.	Sandy Beach		8.5	3.3	82.0	680	8.7	0.6	24	---
10.	Above bromide foot bridge		10.9	16.7	110.0	750	9.0	1.0	26	---
11.	Below inverted siphons at campground		9.2	16.7	81.0	1000	8.8	0.4	24	---
12.	Sulphur treatment plant		---	---	---	---	---	---	---	---
	Outfall of treatment plant		---	---	---	---	---	---	---	---
5.	HY 177 above bridge	6/16	---	---	---	---	---	---	---	---
6.	HY 177 below bridge		8.8	---	64.0	610	8.9	3.6	27	204.2
7.	HY 7 below bridge		11.4	25.4	---	670	8.8	3.6	28	204.2
	Under HY 7 bridge		---	---	---	---	---	---	---	---
8.	Culvert below HY 7		---	---	---	---	---	---	---	---
9.	Sandy Beach		9.9	17.0	86.0	680	9.0	3.2	27	204.2
10.	Above bromide foot bridge		---	---	---	---	---	---	---	---
11.	Below inverted siphons at campground		12.0	12.7	126.0	1020	9.0	0.4	27	233.4
12.	Sulphur treatment plant		8.7	0.0	183.9	1000	8.5	16.0	24	212.5
	Outfall of treatment plant		---	2.6	171.9	---	---	20.4	---	300.0
5.	HY 177 above bridge	6/18 raining	---	---	---	---	---	---	---	---
6.	HY 177 below bridge		---	---	---	---	---	---	---	---
7.	HY 7 below bridge		6.0	225.7	83.0	360	8.3	282.0	31	245.8
	Under HY 7 bridge		8.0	79.2	55.0	640	8.7	---	24	162.5
8.	Culvert below HY 7		---	---	---	---	---	---	---	---

	Site	Date	DO	COD	Cl	TDS	pH	TSS	Temp.	Alkalinity
ROCK CREEK			↙ raining							
9.	Sandy Beach	6/18	---	---	---	---	---	---	---	---
10.	Above bromide foot bridge		---	---	---	---	---	---	---	---
11.	Below inverted siphons at campground		---	---	---	---	---	---	---	---
12.	Sulphur treatment plant		---	---	---	---	---	---	---	---
	Outfall of treatment plant		---	---	---	---	---	---	---	---
5.	HY 177 above bridge	6/23	7.9	22.0	60.0	1065	8.0	3.3	26	316.7
6.	HY 177 below bridge		8.4	22.0	59.0	675	7.8	---	25	291.7
7.	HY 7 below bridge		7.8	---	77.0	640	8.3	---	24.5	283.4
	Under HY 7 bridge		---	---	---	---	---	---	---	---
8.	Culvert below HY 7		---	---	---	---	---	---	---	---
9.	Sandy Beach		9.1	29.4	79.0	690	8.1	---	26.6	287.5
10.	Above bromide foot bridge		---	---	---	---	---	---	---	---
11.	Below inverted siphons at campground		10.4	22.0	175.0	1030	8.2	---	26	300.0
12.	Sulphur treatment plant		8.6	11.8	179.0	1010	7.9	---	26.5	337.5
	Outfall of treatment plant		---	---	---	---	---	---	---	---
5.	HY 177 above bridge	6/29	---	---	---	---	---	---	---	---
6.	HY 177 below bridge		---	---	---	---	---	---	---	---
7.	HY 7 below bridge		---	---	---	---	---	---	---	---
	Under HY 7 bridge		---	---	---	---	---	---	---	---
8.	Culvert below HY 7		---	---	---	---	---	---	---	---
9.	Sandy Beach		6.6	0.0	36.0	1100	8.0	---	27.2	196.9
10.	Above bromide foot bridge		---	---	---	---	---	---	---	---
11.	Below inverted siphons at campground		---	---	---	---	---	---	---	---
12.	Sulphur treatment plant		---	9.9	314.9	---	---	61.3	---	---
	Outfall of treatment plant		---	---	---	---	---	---	---	---

Note: Units mg/l except pH, temperature (°C), TDS (micromhos)

Biochemical oxygen demand

Site	Date	DO	COD	BOD	TDS	ph	TSS	Temp.	Alkalinity
TRAVERTINE CREEK									
1. Below Nature Center	9/5	10	35.7	0.2	550	8.1	---	21.0	---
2. Below Swimming Area		8.4	10.7	0.6	500	8.0	---	23.5	---
3. Culvert E. of HY 177		---	---	---	---	---	---	---	---
14. Little Niagra		9.5	25.0	0.6	550	8.1	---	21.5	---
15. Travertine HY 177		8.1	32.1	0.3	500	7.9	---	24.5	---
1. Below Nature Center	9/18	8.7	0	6.2	550	8.0	---	20.0	---
2. Below Swimming Area		8.0	-7.9	-0.3	500	8.1	---	22.0	---
3. Culvert E. of HY 177		---	---	13.8	---	7.9	---	---	---
14. Little Niagra		8.2	3.9	0.075	500	8.1	---	20.5	---
15. Travertine HY 177		7.1	---	0.75	500	7.9	---	22.5	---
ROCK CREEK									
6. HY 177 below bridge	9/5	8.4	42.8	1.8	2600	7.8	---	24.0	---
7. HY 7 below bridge		7.3	60.7	0.6	2450	7.8	---	25.0	---
Under HY 7 bridge		---	---	---	---	---	---	---	---
8. Culvert below HY 7		---	---	---	---	---	---	---	---
9. Sandy Beach		6.3	46.4	0.6	2350	7.75	---	24.5	---
11. Below inverted siphons at campground		---	---	---	---	---	---	---	---
13. Campgrounds		8.4	42.8	1.2	1850	8.0	---	25.0	---
6. HY 177 below bridge	9/18	7.1	---	0.75	500	7.9	---	22.5	---
7. HY 7 below bridge		5.65	3.9	1.5	2350	7.8	---	23.0	---
Under HY 7 bridge		---	---	---	---	---	---	---	---
8. Culvert below HY 7		---	214.5	20.7	---	7.9	---	---	---
9. Sandy Beach		5.1	9.8	1.5	2300	7.8	---	23.2	---
11. Below inverted siphons at campground		---	9.8	2.4	---	8.0	---	---	---
13. Campgrounds		7.1	9.8	0.3	1950	8.0	---	23.5	---

Discharge from drainage culvert

(June 1976)

		COD		TSS		Alkalinity			Cl			Phos.	TOC
		6/21	6/23	6/21	6/29	6/21	6/23	6/29	6/21	6/23	6/29	6/29	6/29
16.	Rock Creek												
	surface	80.8		17.3	27.3	191.7		184.4	59.0		64.0	0.02	16.0
	bottom	---		---	2.7	---		184.4	---		54.0	0.02	25.6
17.	Guy Sandy												
	surface	97.0		17.3	---	179.2		162.5	37.0		37.0	0.02	63.0
	bottom	113.1		34.0	11.3	254.2		165.6	37.0		38.0	---	155.0
	west of landing- surface	72.7		11.3	---	183.4		---	37.0		---	---	---
	before entering lake	---		---	---	---		196.8	---		36.0	---	---
18.	Buckhorn												
	surface	64.6		12.7	44.7	187.5		181.3	39.0		40.0	0.02	24.0
	bottom	113.1		184.0	30.7	187.5		165.6	41.0		39.0	---	28.0
	E. of HY 177	---		---	166.7	---		296.9	---		14.0	---	---
19.	Dam												
	surface	97.0		4.7	31.3	179.2		171.8	41.0		38.0	0.02	12.4
	bottom	97.0		29.0	56.7	225.0		228.1	41.0		38.0	0.03	15.3
	middle	---		---	30.7	---		175.0	---		37.0	---	13.4
20.	Rock Creek below Arbuckle Dam	---	35.3	---	63.3	---	191.7	228.1	---	37.0	---	---	---

Note: Units in mg/l

TABLE 4. EFFECT OF SWIMMING ON WATER QUALITY

Site	Date	Time	No. of Swimmers	Total Coliform	Fecal Coliform
TRAVERTINE CREEK					
1. Below Nature Center		12:00		41	---
		1:00		44	---
		2:00		55	---
		3:00		37	---
		4:00		53	---
		5:00		42	---
2. Below Swimming Area		12:30	55	162	
		1:00	57	123	
		1:30	111	96	
		2:00	140	132	
		2:30	226	114	
		3:00	253	87	
		3:30	178	93	
		4:00	184	144	
		4:30	104	189	
		5:00	111	324	
1. Below Nature Center	9/5	12:00			860
		1:00		5,000	220
		2:00			24
		3:00			410
		4:00			350
		5:00		38,500	230
2. Below Swimming Area		11:30	96	23,000	2,150
		1:00	102	21,000	1,600
		2:00	138	29,500	2,300
		3:00	206	30,000	2,030
		4:00	137	78,800	---
		5:00	141	28,000	2,450
3. Culvert E. of HY 177				6,000,000	---
4. Little Niagra		11:45	82	21,000	890
		1:00	121	21,200	4,070
		2:00	87	33,600	4,720
		3:00	150	46,600	6,000
		4:00	185	---	7,000
		5:00	95	44,300	6,200

TABLE 4 (cont.)

Site	Date	Time	No. of Swimmers	Total Coliform	Fecal Coliform
TRAVERTINE CREEK					
15. Travertine HY 177					8,740
1. Below Nature Center	9/18	12:00		16,000	490
		1:00		20,000	220
2. Below Swimming Area		12:00	0	22,500	200
		1:00	11	23,400	180
3. Culvert E. of HY 177				1,320,000	155,000
14. Little Niagra		12:00	0	21,600	270
		1:00	9	16,700	280
15. Travertine HY 177				91,000	1,200
ROCK CREEK					
6. HY 177 Below Bridge	9/5			---	1,200
7. HY 7 Below Bridge				---	408
9. Sandy Beach				---	800
6. HY 177 Below Bridge	9/18			260,000	5,000
7. HY 7 Below Bridge				100,000	2,000
8. Culvert Below HY 7				1,320,000	270,000
9. Sandy Beach				640,000	18,000
11. Below Inverted Siphons at Campground				120,000	2,000
13. Campgrounds				830,000	1,000

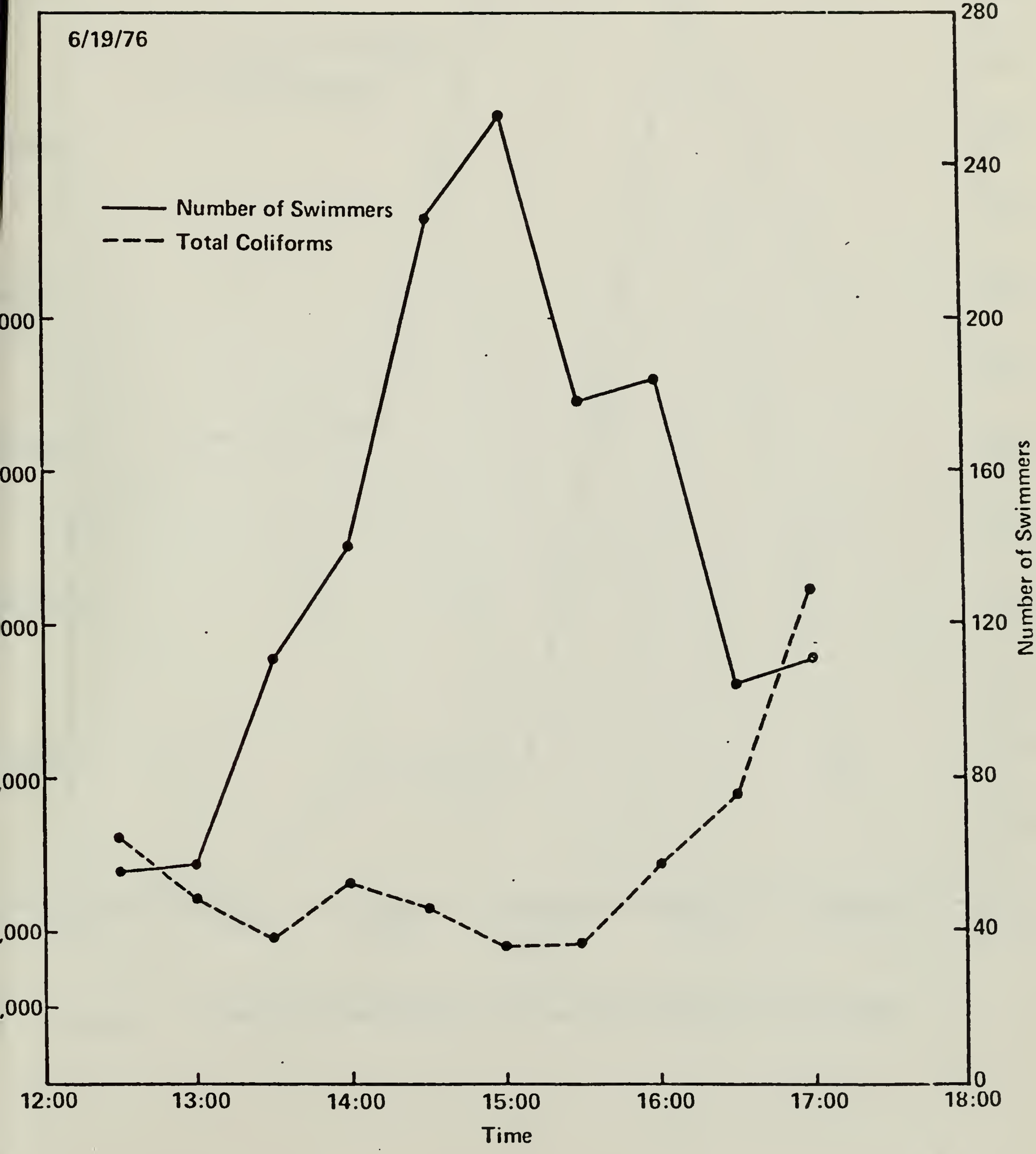

Figure 5 NUMBER OF SWIMMERS vs TOTAL COLIFORM AT TRAVERTINE

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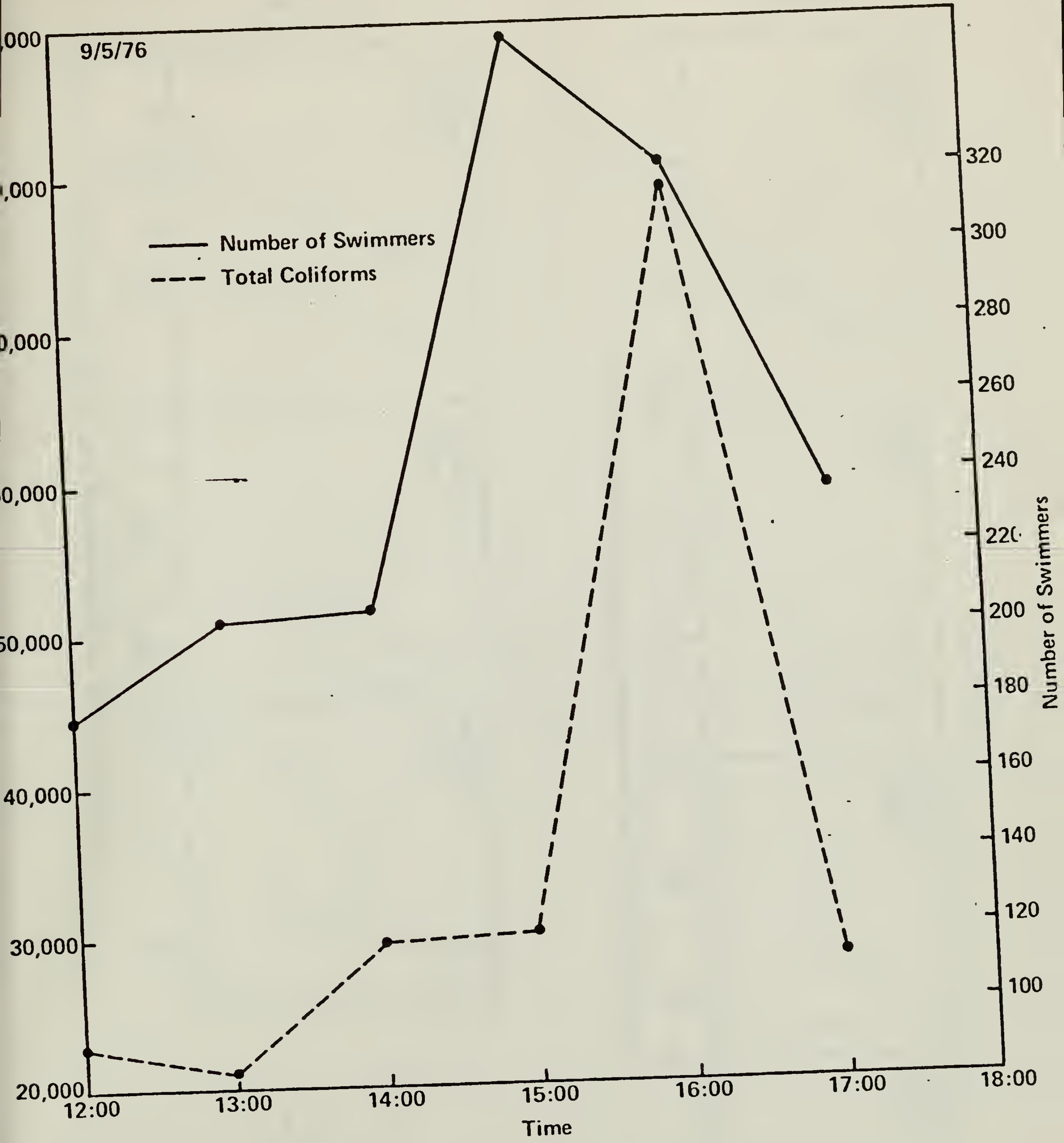
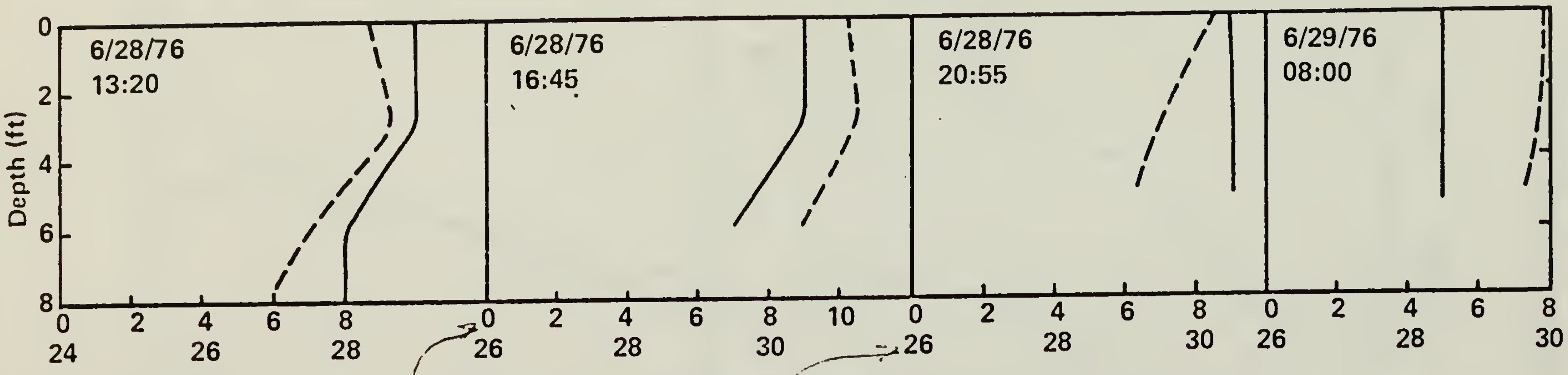


Figure 6 NUMBER OF SWIMMERS vs TOTAL COLIFORM AT TRAVERTINE

Site 16?



Diurnal Dissolved Oxygen and Temperature Study of Rock Creek Arm

Site 17?

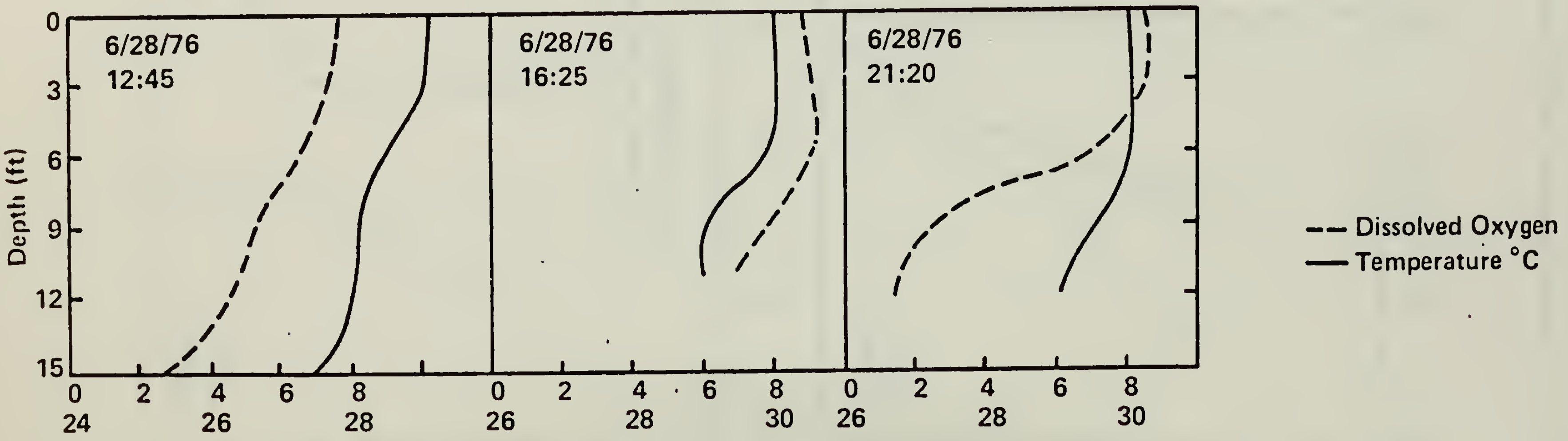


Figure 7 Dirunal Dissolved Oxygen and Temperature Study of Guy Sandy Arm

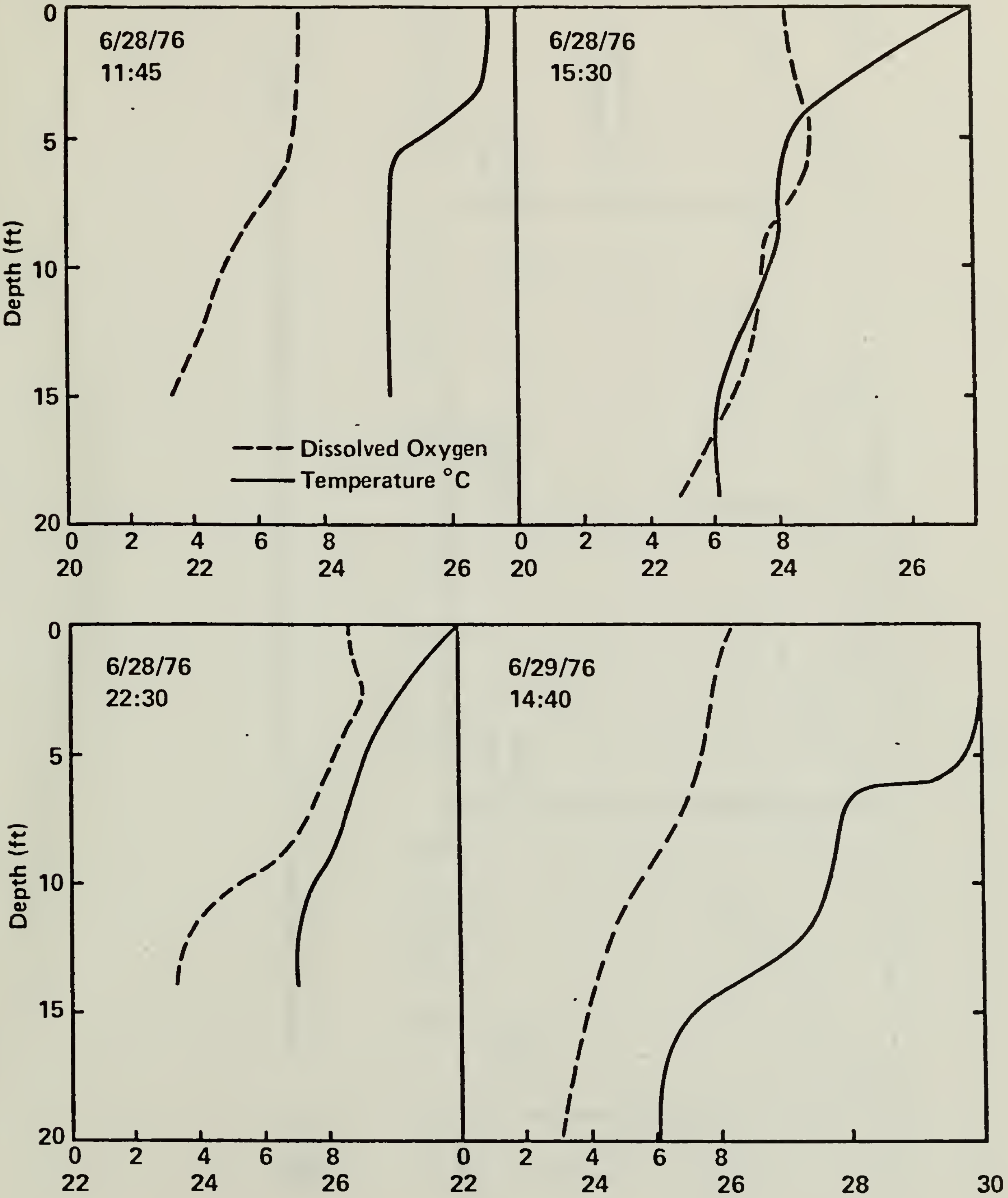


Figure 8 Diurnal Dissolved Oxygen and Temperature Study of Buckhorn Arm

Site 13

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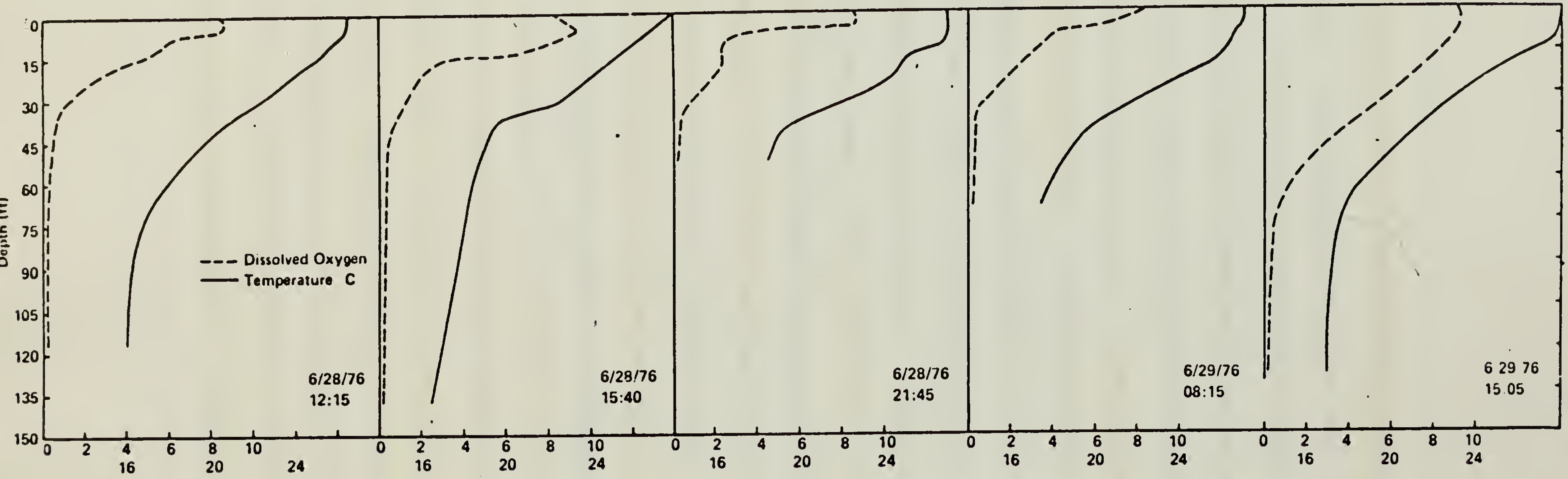

Figure 9 Diurnal Dissolved Oxygen and Temperature Study near dam of Arbuckle Reservoir

Site 19

OBSERVATIONS AND DISCUSSION

The most notable chemical change in any parameter along the two creeks is in the chlorides and total dissolved solids data. The culvert east of Highway 177 on Travertine Creek (site 3) is a contributing source on Travertine Creek for both of these constituents. The chlorides in Rock Creek are generally higher than in Travertine. This appears to be the result of different land uses of the two watersheds and the discharge from OG&E upstream from the City of Sulfur. The sustained flow in Travertine emerges within the boundary of the recreation area and is relatively unpolluted except for the impact of the activities within the National Recreation Area. The sustained flow for Rock Creek is a result of runoff and spring flow from land area several miles upstream from the boundary of the recreation area and flows through range land, feed lots, by OG&E and through the City of Sulfur. There are several sources of pollution discharging into the stream along this stream segment which include OG&E, cattle and hog feeding areas, runoff from city streets and inadvertent discharges due to the poorly maintained and inadequate waste collection system from the municipality. On June 18 the samples were collected during a rainfall event. Site 7 on Rock Creek indicates an increase in COD and BOD resulting from surface runoff. This is also indicated by the analyses performed on the sample taken from the storm sewer below HY 7 (site 8). During the course of this study it is anticipated that more water quality data will be collected during storm events.

The total and fecal coliform concentrations from all sample sites

on Rock Creek (sites 6-9, 11, 13) were found to be very high on every sampling date (Table 4). However, it should be noted that the coliform concentrations were generally highest at sampling site 6 and decreased to lower values at sampling sites downstream. This is due to the animal feed lots upstream from the sampling site 6. As mentioned (on September 18) the drainage culvert, site 8, was discharging into Rock Creek due to surface runoff. This contribution was reflected in a much higher than normal fecal coliform concentration downstream at site 9. Coliform concentrations during the reporting period were observed to be much higher than those reported by Mike Schornick during December of 1975 and January 1976. This is possibly due to animal grazing and feed lot activities mentioned above.

Fecal coliform concentrations on Travertine Creek at site 1 were observed to be higher than the allowable 200/100 ml. for beneficial use G 1. The fecal coliform concentrations remained about the same during the sampling period.

A noticeable increase in total and fecal coliform concentrations due to the number of swimmers in Travertine Creek was observed at sample sites 2 and 14 (see figures 5 and 6). A direct relation between the number of swimmers and the coliform concentrations downstream at site 2 is apparent. The time lag between the change in the number of swimmers and the observed change in coliform concentrations would be expected due to the retention time in traveling between sites 1 and 2. The difference in flow rates and possibly the distribution of swimmers along the creek.

The COD, TOC, and TSS values for the Lake of the Arbuckles are

higher than expected. The alkalinities are high but can be related to the geology of the region. The high TSS values for the samples taken near the bottom on the Guy Sandy arm of the reservoir may be due to mixing of the bottom sediment while obtaining the samples. Literature values indicate that the critical nutrient level for inorganic phosphorus is 0.01 mg./l. In combination with other suitable conditions algal blooms can be expected. In fact on June 29, 1976 high algae concentration were observed visually, the TOC was high, and the diural D.O. concentration curves indicated high algal activity. Referring to figures 7 through 9 it is evident that there is significant eutrophication of the entire lake. The dissolved oxygen concentration is much higher during the daylight hours than after sunset for every sampling site.

ADDITIONAL INFORMATION NEEDED

A fecal strep analysis should be preformed on all samples to differentiate between human and non-human contamination making possible the identification and location of polution sources.

Additional sampling sites should be located to pinpoint the sources of high coliform concentrations at sites 1 and 6.

An effort should be made to collect samples during periods of rainfall to determine contamination impacts of land use and infiltration of sewage systems on the creeks.